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IN THE U. S. PATENT AND TRADEMARK OFFICE

APPLICANTS:	Petter ERICSON	CONF. NO.	1171
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FOR: APPARATUS AND METHOD RELATING TO IMAGE CODING

LETTER SUBMITTING TRANSLATION
OF NON-ENGLISH LANGUAGE PROVISIONAL APPLICATION
PURSUANT TO 35 U.S.C. § 119(e) AND 37 C.F.R. 1.78(a)(5)

Assistant Commissioner for Patents
Washington, D.C. 20231

September 28, 2001

Sir:

In accordance with the requirements of 35 U.S.C. § 119(e) and 37 C.F.R. § 1.78(a)(5), attached hereto is a verified English language translation of U.S. Provisional Application No. 60/207,838 filed on May 30, 2000. This submission completes the claim for priority of this provisional application in the above-identified patent application.

If necessary, the Commissioner of hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. § 1.16 or under § 1.17; particularly, extension of time fees.

Respectfully submitted,
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VERIFIED TRANSLATION

I, the undersigned E. v. Renouard, technical translator, of RWS Translations, do hereby declare:

(1) That I am well familiar with the Swedish and English languages;

(2) That the attached is a true and accurate translation into the English language of the Swedish text of this Patent Application entitled "Apparatus and Methods relating to Images" that was filed in the US Patent and Trademark Office on 30 May 2000.

(3) That all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under § 1001 of title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: this 28th day of August 2000

E. v. Renouard

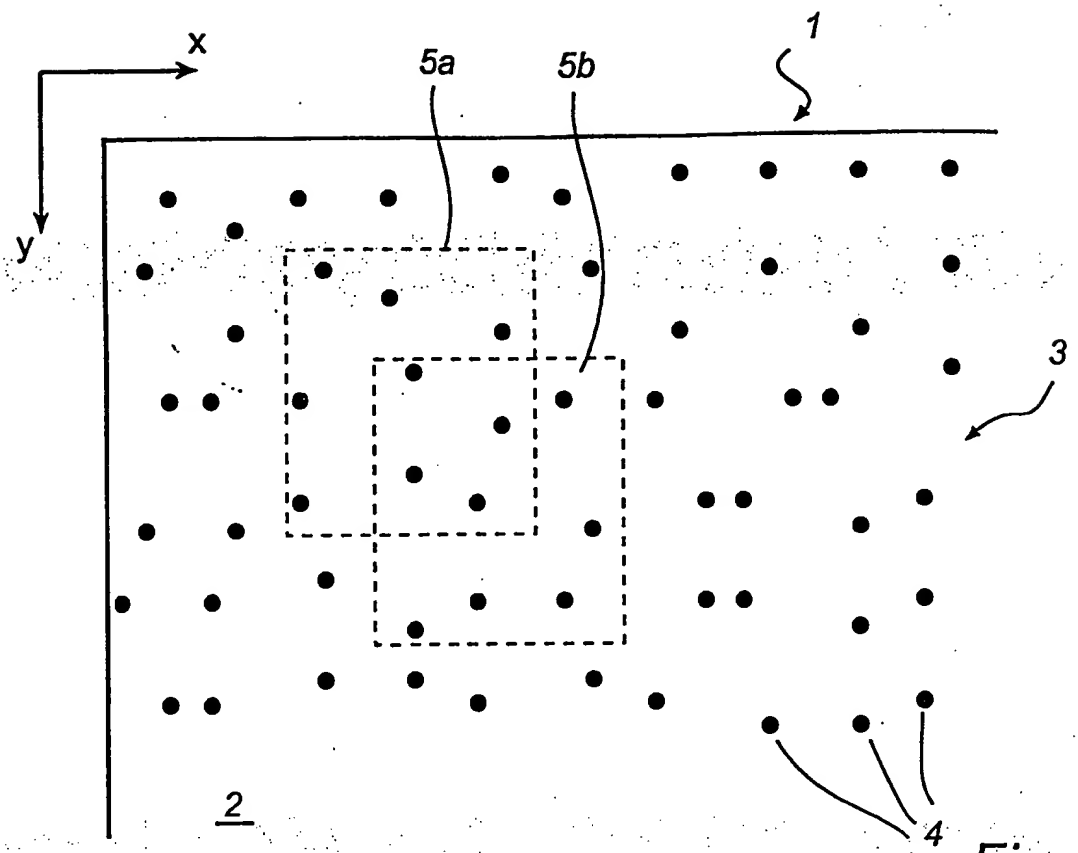

Fig. 1

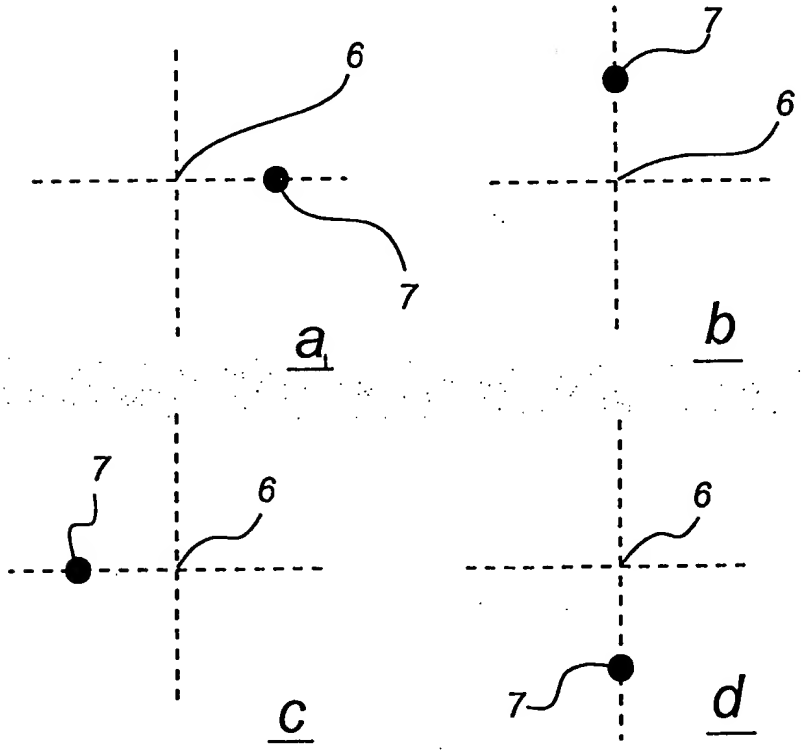

Fig. 2

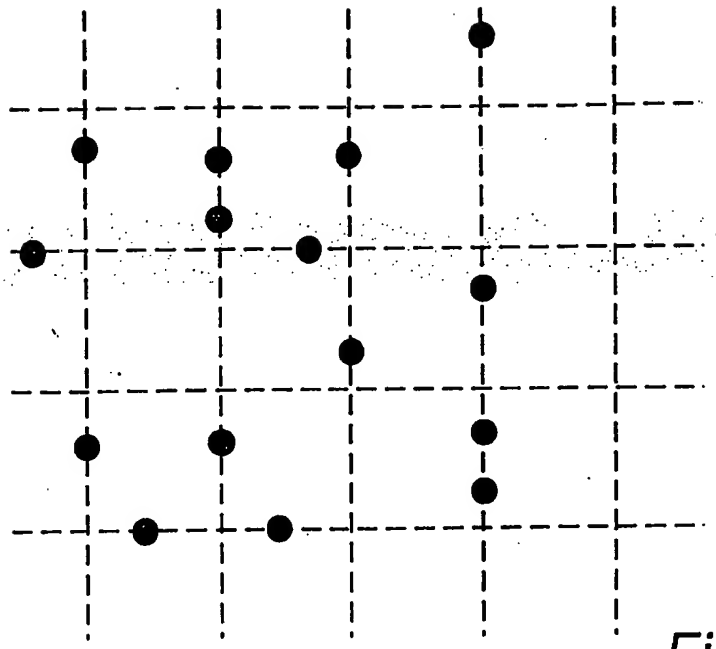

Fig. 3

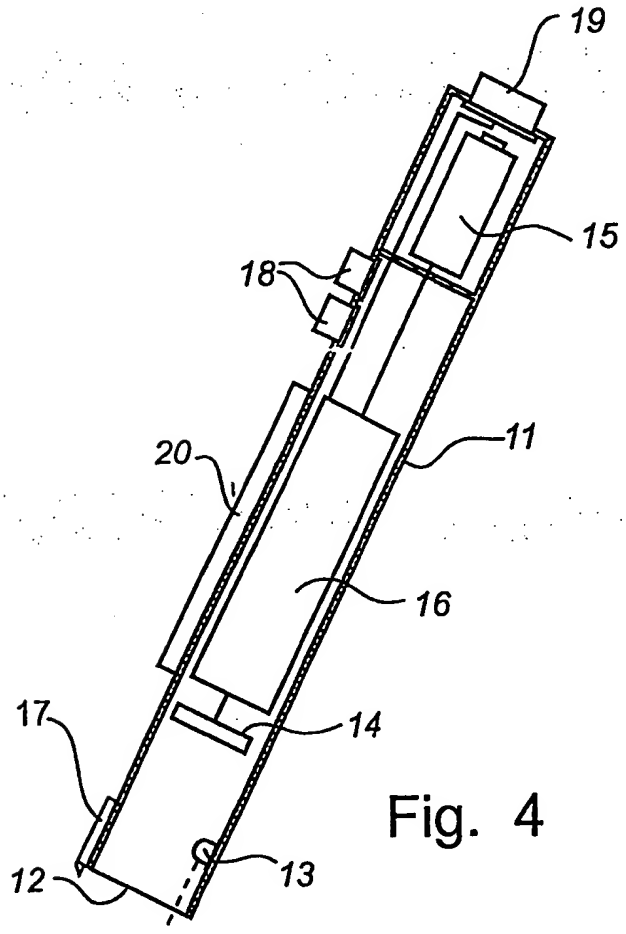

Fig. 4

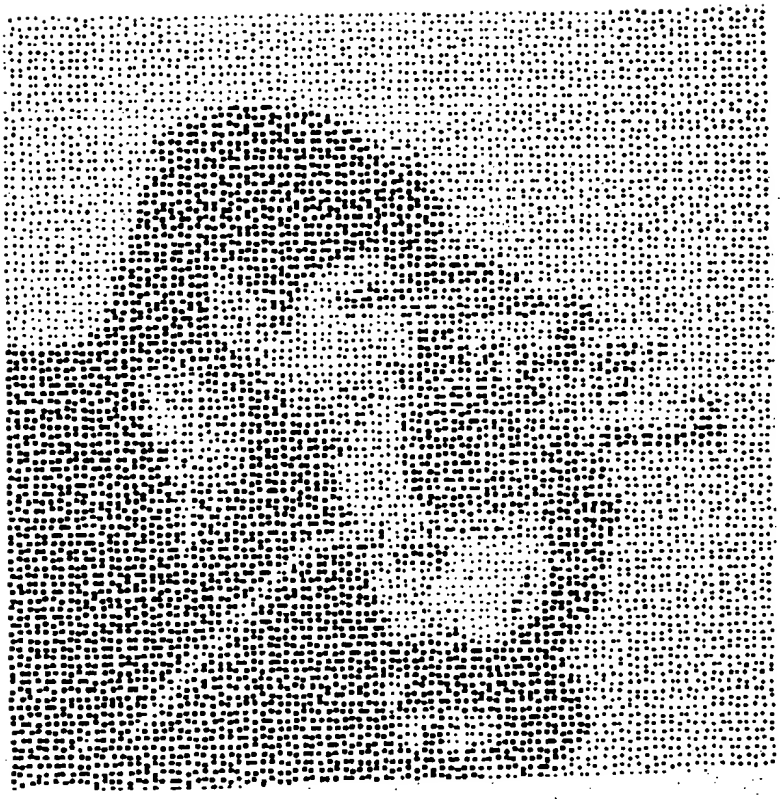

Fig. 5a

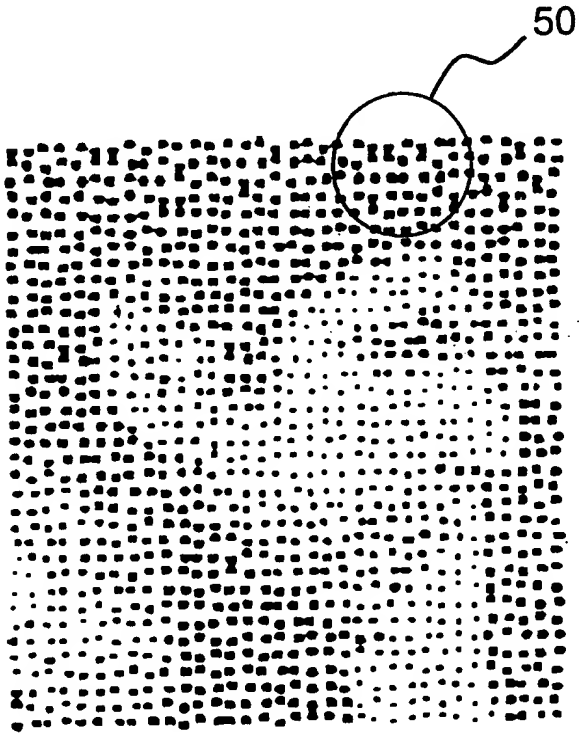

Fig. 5b

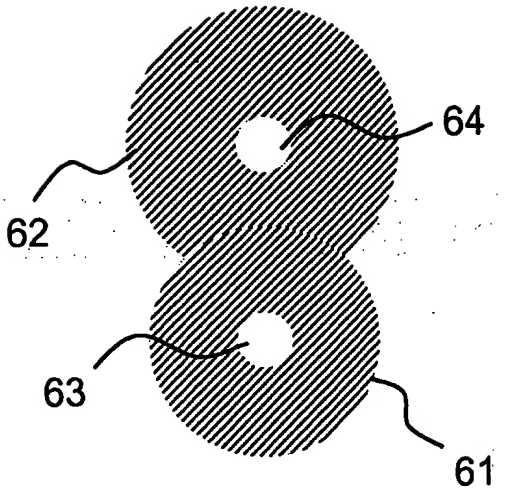

Fig. 6a

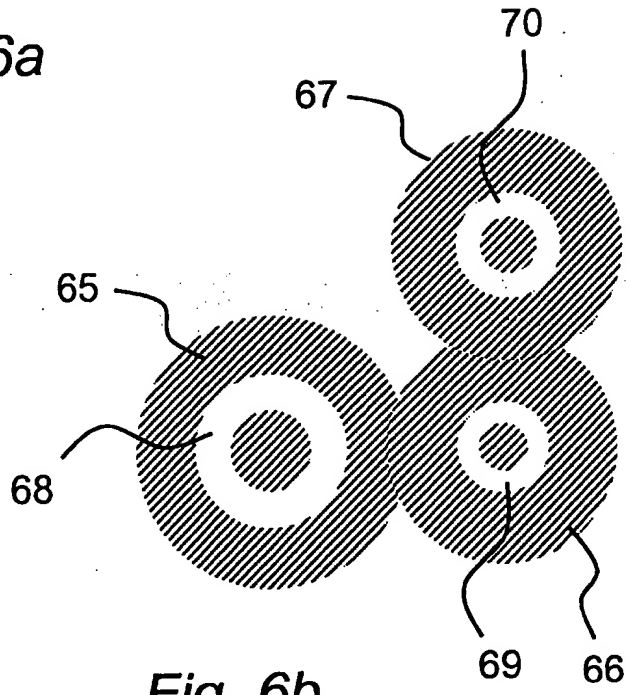

Fig. 6b

AP-0013

3782-128P

UNITED STATES PATENT APPLICATION

OF

PETTER ERICSON

FOR

APPARATUS AND METHODS RELATING TO IMAGES

Field of the Invention

The present invention relates to apparatus and methods relating to surfaces which are provided with images. More specifically, the invention relates to the reading of information from images.

Background of the Invention

In many contexts, both commercial and scientific, it is of importance for it to be possible to create images on a surface, where the image contains as much information as possible. In this context, images can comprise, for example, photographically produced images of real objects and artificially generated images where the information is represented by structures of varying blackness. In addition to the information which is directly visible from the varying blackness over the image, it can be of use to add information to the image which is not directly apparent from the structures of varying blackness.

It is also of importance to be able to read and interpret this information in the images applied to the surface, by means of reading apparatus. Examples can extend from applying and reading images on paper surfaces to applying and reading information from surfaces on products such as containers etc.

One problem is thus to make it possible to store additional information in and reading additional information from images.

Summary of the Invention

The object of the present invention is to solve problems related to the prior art. From a first aspect, this object is achieved by means of a product according to claim 1, from a second aspect it is achieved by means of a method and a computer program according to claims 16 and 18, respectively, and from a third aspect, by means of a method, a computer program and an apparatus according to claims 19, 20 and 21, respectively.

In general, the invention points to aspects related to coding patterns which are applied to a product, where the coding pattern is in a form of an image produced with the aid of a so-called screen-printing technique.

Screen-printed images are made up of a large number of picture elements in the form of points, so-called raster points. An image is characterized by spatially varying density where the variations in density are represented by varying extents of the raster points. Depending on the equipment used for generating the images with the aid of this technique, a widely varying quality in terms of spatial resolution and in terms of number of levels of density can be produced. A determining factor is the capacity of the equipment with respect to the size of the raster points and the nature of the surface on which the image is to be printed.

A product according to the invention thus has, according to the first aspect, a surface which is pro-

vided with an image in the form of a coding pattern. The coding pattern comprises symbols which represent at least two different values, where each symbol comprises one raster point and at least one marking. The raster point is part of a raster which extends over the surface and the value of each symbol is indicated by the placement of the said marking with respect to a raster point. The markings each have a spatial extent which, in combination, at least partially forms the image.

The effect which is achieved according to the first aspect of the invention is thus that the possibility is obtained of reading additional information from an image which is printed on a product with the aid of a screen-printing technique. One advantage with respect to the prior art is certainly that the amount of information which can be read from the image is larger. Images printed according to the prior art without an information-carrying coding pattern thus lack the additional "layer" of information which is contained in the coding pattern.

According to the second aspect of the present invention, an image in the form of a coding pattern can be produced by a method. The coding pattern comprises symbols which represent at least two different values and each symbol comprises a raster point and at least one marking. The raster point is included in a raster which extends over the surface and the value of each symbol is indicated by the placement of said markings in relation

to a raster point. For each one of the markings, the spatial extents of the markings, which, in combination, at least partially form the image, are determined on the basis of information in the image.

The effect which is achieved according to the second aspect of the invention is thus that the possibility is obtained of providing an image, which is printed on a product with the aid of screen-printing technique, with additional information beyond the information which is inherent in the image. An advantage with respect to the prior art is of course that the amount of information which can be stored in the image is larger. Images printed according to the prior art, without an information-carrying coding pattern, thus lack the additional "layer" of information which is contained in the coding pattern.

In slightly more specific terms, these two aspects of the invention can be described by an original image which is to be printed, for example, in a newspaper, normally being printed according to a screen-printing technique which consists of the image being printed as a plurality of small points which are regularly arranged in a raster (i.e. a grid network with one point at each crossing between two lines). Different degrees of density, i.e. graytones, are produced in the image by the points being made to be of different size. In an area which is to be black, the points are made large and in an area which is to be light, the points are made small. One

concept according to the invention is to code additional information, for example in the form of positions, text, numbers etc., in the image by each point being displaced from its normal position in the grid network. If the point is displaced a given distance upward from the normal position in the grid network, the point codes the value 00, the same distance to the right the point codes the value 10, the same distance downward gives the value 11 and the same distance to the left gives the value 01. A set of displaced points together gives binary numbers which code information. Since the points are relatively small and the displacements are also relatively small, there appears to be no difference to the naked eye in the image, but with an apparatus according to the invention, the displacement of the points can be read and the information in the image can be decoded. As mentioned, the coded information can be, for example, positions which make it easier to scan in the image, or text, for example an explanation of the image, or copyright information.

A general advantage of pattern and pattern production according to the aspects of the invention is more or less related to the fact that this is a digital operation. The positions of the markings are entered and interpreted as binary numbers, in which case the equipment to be used can be of relatively simple nature.

A more or less problematic situation which can arise in the printing of markings, i.e. screen-printing points,

with varying spatial extents is of course that the markings can overlap one another in certain areas. These areas are characterized by a relatively high density. Such overlappings make it more difficult to determine the location of single markings and thus make it more difficult to read the additional information which is coded in the markings. Certainly, the problem can be avoided by markings which can be expected to overlap being limited in their spatial extents even before the printing. However, this entails limiting the dynamic range with respect to the density variation which characterizes the image which is to be printed with the coding pattern.

Known solutions with respect to the determination of the locations of overlapping markings can be drawn from, for example, the technique of astrometrically determining positions of imaged stars which are located in dense starfields. This technique tells us that with knowledge gathered in advance about the appearance, in the form of intensity distribution within the markings, of single markings, the positions of the markings, i.e. the positions of the stars, can be determined even if a plurality of the markings overlap one another. Three-dimensional pattern recognition algorithms are applied which more or less directly give, for example, the center point of a marking which "flows together" with adjoining markings.

A disadvantage of the known astrometrical technique is that it presupposes that the three-dimensional appearance of the markings in the form of intensity distribution is known in advance in order for the pattern recognition algorithm to be able to deliver a reasonable assumption of the center point of the marking.

With an appearance, i.e. spatial extent (form) and size, determined in advance for each one of the markings which are to constitute a pattern, a pattern can thus be produced according to the invention. Markings are provided with changes determined in advance. The changes occur advantageously in the spatial configuration of the markings and can be more or less regular. The changes are to be preferably so regular that it will be possible in subsequent reading of the pattern with its markings to recognize the marking, when an identification of the change is made, without necessarily having read the marking in its complete spatial extent. Once the marking is recognized, for example, its center point can be determined.

The changed markings can imply, for example, that overlapping markings comprise at least one contrasting indicator, the spatial extent and place within the marking of which indicate the center point of the marking. Certainly, these contrasting indicators can be of more or less arbitrary configuration but it certainly suggests itself to utilize simple symbols such as points, circles

or rectangles since reading and interpreting such symbols requires a limited set of image analysis operations to detect them.

An advantage of patterns and producing patterns according to the above is that a large dynamic range of density levels can be obtained whilst retaining the readability. It is thus possible to print patterns which contain large markings/raster points without, for example, losing the digitally coded position information.

According to the third aspect of the invention, a coding pattern located in the image and containing symbols is read. As according to the above aspects, the symbols represent at least two different values, each symbol comprising one raster point and at least one marking. The raster point is included in a raster which extends over the surface and the value of each symbol is indicated by the placement of said marking in relation to a raster point. The method comprises determining markings which at least partially overlap one another and reading for each one of these overlapping markings at least one contrasting indicator, the spatial extent and place within the marking of which indicate the placement of the marking.

Reading can be advantageously carried out by means of an apparatus which can be handheld and communicate wirelessly with, for example, a computer which receives both image information and information from the coding pattern which is read.

Brief Description of the Drawings

In the text which follows, the invention will be described in greater detail through embodiments and referring to the accompanying drawings.

Fig. 1 schematically shows an embodiment of a product according to the present invention which is provided with a position-coding pattern.

Figs 2a-2d schematically show how the symbols can be configured in an embodiment of the invention.

Fig. 3 schematically shows an example of 4x4 symbols which are used for coding a position.

Fig. 4 schematically shows an apparatus according to the present invention which can be used for reading a coding pattern.

Fig. 5a shows an image in the form of a coding pattern which comprises markings with varying sizes.

Fig. 5b shows a detail from the image in Fig. 5a.

Figs 6a and 6b show details from an image where overlapping markings have been provided with contrasting indicators.

Description of Preferred Embodiments

For the sake of clarity, the detailed description of the invention below is divided into a number of part-descriptions. As an introduction, a coding pattern will be presented with reference to Figs 1, 2a-d and 3. This coding pattern can be used for information storage as has been outlined above. As an example, the information stor-

ed in the pattern has been selected to be position information. After the presentation of the coding pattern, an apparatus which is intended for reading the pattern is then presented in connection with Fig. 4. After that is shown how an image can be produced by printing a screen pattern in the form of the coding pattern presented, comprising markings of varying extents, referring to Figs 5a and 5b. Finally, a method of modifying the appearance of the pattern markings which, on printing an image, overlap one another, is presented with reference to Figs 6a and 6b.

Fig. 1 shows a part of a product in the form of a sheet of paper 1 which is provided on its surface 2 with an optically readable position-coding pattern 3 which enables position determination to be performed. The position-coding pattern consists of symbols 4 which are systematically arranged over the surface 2 so that it has a "patterned" appearance. The symbols comprise markings which in Fig. 1 are round and of constant size for the sake of clarity.

The paper has an x coordinate axis and a y coordinate axis. In this case, the position determination can be carried out on the surface of the entire product. In other cases, the surface which allows the position determination may constitute a lesser part of the product.

The position-coding pattern comprises a virtual raster which is thus neither visible to the human eye nor

can it be detected directly by an apparatus which is to determine positions on the surface, and a plurality of symbols 4 each of which can assume one of four values "1" - "4" as is described in the text which follows. In this connection it should be pointed out that the position-coding pattern in Fig. 1 is greatly enlarged for the sake of clarity. Moreover, it is shown only on part of the paper.

The position-coding pattern is arranged in such a manner that the position of a partial surface on the writing surface is coded by symbols on this partial surface. A first and a second partial surface 5a, 5b are shown with dashed lines in Fig. 1. The part of the position-coding pattern (here 3 x 3 symbols) which is located on the first partial surface 5a codes a first position and the part of the position-coding pattern which is located on the second partial surface 5b codes a second position. The position-coding pattern is thus partly common to the adjoining first and second positions. Such a position-coding pattern is designated as "floating" in this application.

Figs 2a-d show an embodiment of a symbol which can be used in the position-coding pattern according to the invention. The symbol comprises a virtual raster point 6 which is represented by the intersection between the raster lines, and a marking 7 which has the form of a point. The value of the symbol is based on where the

marking is placed. In the example in Fig. 2, four possible placements are located, one on each of the raster lines which start from the raster points. The displacement from the raster point is of the same magnitude for all values. In the text which follows, the symbol has the value 1 in Fig. 2a, the value 2 in Fig. 2b, the value 3 in Fig. 2c and the value 4 in Fig. 2d. Expressed differently, there are four different types of symbols.

Each symbol can also represent four values "1-4". This entails that the position-coding pattern can be divided into a first position code for the x coordinate and a second position code for the y coordinate. The dividing is carried out according to the following:

Symbol value	x code	y code
1	1	1
2	0	1
3	1	0
4	0	0

The value of each symbol is thus translated into a first digit, in this case bit, for the x code and into a second digit, in this case bit, for the y code. In this way two completely independent bit patterns are obtained. The patterns can be combined into a common pattern which is graphically coded by means of a plurality of symbols according to Fig. 2.

Each position is coded by means of a plurality of symbols. In this example, 4x4 symbols are used for coding a position in two dimensions, i.e. an x coordinate and a y coordinate.

The position code is made up by means of a number series of ones and zeros which have the characteristic that no sequence of four bits occurs more than once in the series. The number series is cyclic which means that the characteristic also applies if the end of the series is coupled together with its beginning. A sequence of four bits thus always has an unambiguously determined position in the number series.

The series can be maximally 16 bits long if it has the characteristic of sequences of four bits described above. In this example, however, only a seven-bits-long series according to the following is used:

"0 0 0 1 0 1 0"

This series contains seven unique sequences of four bits which code a position in the series according to the following:

Position in the series	Sequence
0	0001
1	0010
2	0101
3	1010
4	0100
5	1000
6	0000

For coding the x coordinate, the number series is written sequentially in columns over the entire surface which is to be coded. The coding is based on the difference or position displacement between numbers in adjoining columns. The magnitude of the difference is determined by the position in the number series at which the column is to begin (i.e. with which sequence). More specifically, if the difference modulo seven is taken between, on the one hand, a number which is coded by a four-bit sequence in a first column and which can thus have the value (the position) 0-6, and, on the other hand, a corresponding number (i.e. the sequence of the same "height") in an adjoining column, the result will be the same independently of where along the two columns the comparison is made. Thus, it is possible to code an x coordinate which is constant for all y coordinates by means of the difference between two columns.

Since each position on the surface is coded by 4x4 symbols in this example, this provides access to three

differences (with the value 0-6), according to the above for coding the x coordinate. The coding is then done in such a manner that of the three differences, one will always have the value 1 or 2 and the other two will have the value in the interval 3-6. No differences will thus be zero in the x code. In other words, the x code is constructed in such a manner that the differences will be as follows:

(3-6) (3-6) (1-2) (3-6) (3-6) (1-2) (3-6) (3-6) (1-2)...

Each x coordinate is thus coded with two numbers between 3 and 6 and a subsequent number which is 1 or 2. Subtracting 3 from the high numbers and one from the low one, a number is obtained in a mixed base which directly provides a position in the x direction from which the x coordinate can then be determined directly as is shown in the example below.

Using the principle described above, it is thus possible to code x coordinates 0, 1, 2..., by means of numbers which represent three differences. These differences are coded with a bit pattern which is based on the above number series. Finally, the bit pattern can be coded graphically by means of the symbols in Fig. 2.

In many cases, when inputting 4x4 symbols, one does not obtain a complete number which codes the x coordinate but parts of two numbers. Since the least significant part of the numbers is always 1 or 2, however, a complete number can be reconstructed in a simple manner.

The y coordinates are coded in accordance with the same principle which is used for the x coordinates. The cyclic number series is written repeatedly in horizontal rows over the surface which is to be position-coded. Exactly as in the case of the x coordinates, the rows are allowed to begin at different positions, i.e. with different sequences, in the number series. For the y coordinates, however, differences are not used but the coordinates are coded with numbers which are based on the starting position of the number series in each row. Having determined the x coordinate for 4x4 symbols, it is possible to determine the starting positions in the number series for the rows which are included in the y code in the 4x4 symbols. In the y code, the most significant number is determined by allowing it to be the only one which has a value in a specific interval. In this example, one row of four is allowed to begin in position 0-1 in the number series to indicate that this row relates to the least significant number in a y coordinate, and the other three begin in position 2-6. In the y direction, there is thus a number series according to the following:

(2-6) (2-6) (2-6) (0-1) (2-6) (2-6) (2-6) (0-1) (2-6)...

Each y coordinate is thus coded with three numbers between 2 and 6 and a subsequent number between 0 and 1.

Subtracting 1 from the low number and 2 from the high ones provides in the same manner as for the x direc-

tion a position in the y direction in mixed base from which the y coordinate can be determined directly.

Using the above method, 4 x 4 x 2 = 32 positions can be coded in the x direction. Each such position corresponds to three differences which provides 3 x 32 = 96 positions. Furthermore, 5 x 5 x 5 x 2 = 250 positions can be coded in the y direction. Each such position corresponds to 4 rows which provides 4 x 250 = 1000 positions. Altogether, 96,000 positions can thus be coded. Since the x coding is based on differences, however, it is possible to select the position in which the first number series begins. Taking into consideration that the first number series can begin at seven different positions, it is possible to code 7 x 96,000 = 672,000 positions. The starting positions for the first number series in the first column can be calculated when the x coordinate has been determined. The above-mentioned seven different starting positions for the first series can code different sheets or writing surfaces on a product.

For further illustrating the invention according to this embodiment, a specific example follows here which is based on the embodiment of the position coding described.

Fig. 3 shows an example of an image with 4x4 symbols which are read by an apparatus for position determination.

These 4x4 symbols have the following value:

4 4 4 2

3 2 3 4

4 4 2 4

1 3 2 4

These values represent the following binary x and y code:

x code:	y code:
0 0 0 0	0 0 0 1
1 0 1 0	0 1 0 0
0 0 0 0	0 0 1 0
1 1 0 0	1 0 1 0

The vertical x sequences code the following positions in the number series: 2 0 4 6. The differences between the columns become -2 4 2 which modulo 7 provides: 5 4 2 which, in mixed base, codes position (5-3) x 8 + (4-3) x 2 + (2-1) = 16 + 2 + 1 = 19. Since the first coded x position is position 0, the difference which lies in the interval 1-2 and which appears in the 4x4 symbols is the twentieth such difference. Since there is also a total of three columns for each such difference and there is a start column, the vertical sequence furthest to the right in the 4x4 x code belongs to the 61st column in the x code (3 x 20 + 1 = 61) and that furthest to the left to the 58th.

The horizontal y sequences code the positions 0 4 1 3 in the number series. Since these series begin in the 58th column, the starting position of the rows is

these numbers minus 57 modulo7 which provides the starting positions 6 3 0 2. Translated into digits in the mixed base, this becomes 6-2, 3-2, 0-0, 2-2 = 4 1 0 0, where the third digit is the least significant digit in the current number. The fourth digit is then the most significant digit in the next number. In this case, this must be the same as in the current number. (The exception is when the current number consists of the highest possible digits in all positions. It is then apparent that the start of the next number is one greater than the start of the current number).

The position of the four-digit number becomes $0 \times 50 + 4 \times 10 + 1 \times 2 + 0 \times 1 = 42$ in the mixed base.

The third row in the y code is thus the 43rd which has starting position 0 or 1 and since there are four rows in total for each such row, the third row is number $43 \times 4 = 172$.

In this example, the position for the top left corner of the 4x4 symbol group is thus (58,170).

Since the x sequences in the 4x4 group begin in row 170, the x columns of the entire pattern begin in positions ((2 0 4 6) -169) mod 7 = 1 6 3 5 of the number series. Between the last starting position (5) and the first starting position, the numbers 0-19 are coded in the mixed base and by summing up the representations for the numbers 0-19 in the mixed base, the total difference between these columns is obtained. A primitive algorithm

for doing this is to generate these twenty numbers and directly summing up their digits. The sum obtained is called s. The sheet or writing surface is then given by (5-s) modulo7.

In the above example, an embodiment has been described where each position is coded with 4x4 symbols and a number series with 7 bits is used. Naturally, this is only one example. Positions can be coded with more or fewer symbols. They do not need to be the same amount in both directions. The number series can have different lengths and does not need to be binary but can be based on another base. Different number series can be used for coding in the x direction and coding in the y direction. The symbols can have a different number of values.

Furthermore, in the above example the marking is a point. Naturally, this can have another appearance. For example, it can be in the form of a line which begins at the virtual raster point and extends from there to a certain position.

In the above example, the symbols are used within a square partial surface for coding a position. The partial surface can have a different shape, for example hexagonal. Neither do the symbols need to be arranged in rows and columns at 90° angles with respect to one another but can also be arranged in other configurations.

For the position code to be detectable, the virtual raster needs to be determined. This can be done by study-

ing the distance between different markings. The shortest distance which is found between two markings must originate from two adjoining symbols with the value 1 and 3 so that the markings are lying on the same raster line between two raster points. Once such a pair of markings has been detected, the associated raster points can be determined with knowledge of the distance between the raster points and the displacement of the markings from the raster points. When two raster points have been localized, additional raster points can be determined by means of measured distances to other markings and with knowledge of the mutual distances between the raster points.

Fig. 4 schematically shows an embodiment of an apparatus for position determination. It comprises a casing 11 which has the approximate form of a pen. In the short end of the casing, an opening 12 is located. The short end is intended to bear against, or be held at a small distance from, the surface to which an image is applied and the position determination or more general information gathering is to take place.

The casing contains mainly an optics part, an electronic circuitry part and a power supply.

The optics part comprises at least one light-emitting diode 13 for illuminating the surface which is to be imaged and a light-sensitive area sensor 14, for example

a CCD or CMOS sensor, for registering a two-dimensional image. The apparatus may also contain a lens system.

The power supply for the apparatus is obtained from a battery 15 which is mounted in a separate compartment in the casing.

The electronic circuitry part contains an image-processing means 16 for determining a position on the basis of the image recorded by the sensor 14 and, more specifically, a processor unit with a processor which is programmed for reading images from the sensor and carrying out the position determination on the basis of these images.

Thus, the apparatus in this embodiment can also comprise a pen point 17 with the aid of which one can write normal pigment-based writing on the surface on which the position determination is to take place. The pen point 17 can be retracted and extended so that the user can control if it is to be used or not. In certain applications, the apparatus does not need to have any pen point at all.

The apparatus also comprises buttons 18 with the aid of which the apparatus is activated and controlled. It also has a transceiver 19 for wireless transmission, e.g. by IR light or radiowaves, of information to and from the apparatus. The apparatus can also comprise a display 20 for showing positions or recorded information.

In Swedish Patent No. 9604008-4 of the Applicant, an apparatus for recording text is described. This apparatus can be used for position determination if it is programmed in a suitable manner. If it is to be used for pigment-based writing, it must also be provided with a pen point.

The apparatus can be divided into different physical casings, a first casing containing components which are necessary for capturing images of the position-coding pattern and for transferring these to components which are located in a second casing and which carry out the position determination on the basis of a recorded image or images.

As mentioned, the position determination is done by a processor which thus must have software for locating and decoding the symbols in an image and for determining positions from the codes thus obtained. From the above example, a person skilled in the art can design software which carries out position determination on the basis of an image of a part of a position-coding pattern.

Furthermore, a person skilled in the art can design software for printing the position-coding pattern on the basis of the above description.

In the embodiment above, the pattern can be read optically and the sensor is thus optical. As mentioned, the pattern can be based on another parameter than an optical parameter. In this case, the sensor must natu-

rally must be of a type which can read the current parameter.

In the embodiment above, the raster is a grid network. It can also have other forms.

In the embodiment above, it is not the longest possible cyclic number series which is used. This results in a certain redundancy which can be used, for example, for checking the turning of the read group of symbols.

Fig. 5a shows an image which is produced of a coding pattern, the symbols of which comprise markings of varying sizes. The symbols are part of a coding pattern according to the description above in connection with Figs 1-3. The aim of Fig. 5a is to illustrate that varying density can be produced with the aid of symbol markings according to the invention. For the sake of clarity, however, the image is shown at a very coarse scale. Certainly, the sizes of the markings and thus the detail resolution depend on the capacity of the printing device which generates the image printout as can be easily understood by a person skilled in the art.

Fig. 5b shows a detail from the image in Fig. 5a and shows more clearly than in Fig. 5a how the markings can vary in spatial extents. A large number of markings have such positions, determined by the coding, and extents so that they overlap adjacent markings. An example of an area 501 which contains such overlappings is pointed out in Fig. 5b. It should be noted that the markings as shown

in Figs 5a and 5b do not have the same general appearance as the markings shown in Figs 1-3 which are more or less circular. This illustrates the fact that, within the scope of this invention, the appearance of the markings is not limited to some specific shape but can advantageously depend on the capacity of the printing device at least to a certain degree. The examples in Figs 5a and 5b originate from a conventional laser printer with limited detail resolution which is why the shapes of the markings vary.

Figs 6a and 6b show schematic illustrations of markings 61, 62, 65, 66, 67 which overlap one another. The markings are presented in the form of filled-in circles. For the sake of clarity, the fillings have been carried out by means of shading in contrast to the solidly filled-in markings which were illustrated earlier in Figs 1-3 and 5. The markings in Figs 6a and 6b have also been provided with contrasting indicators 63, 64, 68, 69, 70.

The overlapping markings 61, 62 in Fig. 6a are provided with respective circular contrasting indicators 63, 64 which are placed in the center of the respective marking. The overlapping markings 65, 66, 67 in Fig. 6b are provided with respective contrasting indicators 68, 69, 70 in the form of circles which are concentric with the respective marking and centered with respect to the center of the respective marking.

On generating an image which comprises picture elements which have such density that one or more markings which are to represent the density are allocated such a spatial extent that they overlap one another according to Figs 6a or 6b, the markings are provided with a contrasting indicator. The generation of markings is preferably done by means of software in a suitably programmed computer. The generating process comprises determining, with knowledge of the density of each picture element, the extents of the markings and deciding if adjacent markings are to overlap one another on printing or printout. If such overlappings are found, these markings are provided with a contrasting indicator according to, for example, one of the illustrations in Figs 6a or 6b. However, it should be pointed out once again that the markings and the contrasting indicators can be of more or less arbitrary form.

Inputting of symbols which comprise markings with contrasting indicators is preferably done by means of a computer provided with suitably designed software. An inputting process comprises detecting two or more overlapping markings. The detection can comprise, for example, inputting of a spot of undetermined spatial configuration, the appearance of which, for example, can be one of the illustrations in Figs 6a or 6b. On such a finding, the software executes an analysis of the appearance of the spot according to known image-analysis technique, in

which contrasting indicators are identified. These contrasting indicators, for example those which are illustrated in Figs 6a or 6b, are then analyzed in terms of position and extent, a center point of the respective indicators being found and interpreted as a center point of a respective marking.

Although the storage of position information in a coding pattern, and reading of position information from a coding pattern, is shown in the above example, other information can also be relevant, for example text in the form of, for example, an explanation of the image or copyright information.

What I claim and desire to secure by Letters Patent is:

1. A product which has a surface (2) which is provided with an image in the form of a coding pattern (3) which comprises symbols (4) which represent at least two different values, each symbol comprising a raster point (5) and at least one marking (6); the raster point being included in a raster which extends over the surface; the value of each symbol being indicated by the placement of the said marking in relation to a raster point; and the markings each having a spatial extent which, in combination, at least partially form the image.

2. A product according to claim 1, wherein the spatial extents of the markings vary insofar as the markings have essentially identical form and varying size.

3. A product according to any one of claims 1-2, wherein the spatial extents of the markings vary inasmuch as the markings which at least partially overlap one another comprise at least one contrasting indicator (63, 64, 68, 69, 70), the spatial extent and place within the marking of which indicate the center point of the marking.

4. A product according to claim 3, wherein the contrasting indicator is in the form of at least one circle.

5. A product according to claim 3, wherein the contrasting indicator is in the form of at least one point.

6. A product according to claim 3, wherein the contrasting indicator is in the form of at least one rectangle.

7. A product according to any one of the preceding claims, wherein the coding pattern is a position-coding pattern which codes a plurality of positions on the surface, each position being coded by a plurality of symbols.

8. A product according to claim 7, wherein each symbol (4) contributes to the coding of more than one of said plurality of positions.

9. A product according to claim 7 or 8, wherein each symbol (4) contributes to the coding of both a first and a second position coordinate.

10. A product according to claim 9, wherein the value of each symbol can be translated to at least one first number which is used for coding the first position coordinate and at least one second number which is used for coding the second position coordinate, the symbols in the position-coding pattern together representing a first position code for the first position coordinate and a second position code for the second position coordinate.

11. A product according to any one of claims 7-10, wherein the position-coding pattern (3) is based on a first cyclic number series which has the characteristic that no sequence with a first predetermined number of figures occurs more than once in the number series.

12. A product according to claim 8, wherein the first coordinate is coded in that a first cyclic number series, which has the characteristic that no sequence with a first predetermined number of figures occurs more than once in the number series, is repeated in columns over the surface, the columns beginning at different places in the number series.

13. A product according to claim 12, wherein the second coordinate is coded in that a second cyclic number series, which has the characteristic that no sequence with a second predetermined number of figures occurs more than once in the number series, is repeated in rows over the surface, the rows beginning at different places in the number series.

14. A product according to any one of the preceding claims, in which the said raster and said raster point are virtual.

15. A product according to any one of the preceding claims, wherein each symbol has precisely one marking which can be placed in any of four predetermined positions on the lines of the raster so that the symbol has precisely four values.

16. A method for generating an image in the form of a coding pattern (3) which contains symbols (4), wherein the symbols represent at least two different values, each symbol comprising a raster point (5) and at least one marking (6); the raster point being included in a raster

(continued)

(continued claim 16)

which extends over the surface; the value of each symbol is indicated by the placement of said markings in relation to a raster point; and comprising the step of determining for each of the markings, on the basis of information in the image, the spatial extents of the markings which, in combination, at least partially form the image.

17. A method according to claim 16, wherein the determining of the spatial extents of the markings comprises determining markings which at least partially overlap one another and determining for the overlapping markings at least one contrasting indicator (63, 64, 68, 69, 70), the spatial extent and place within the marking of which indicate the center point of the marking.

18. A computer program which is stored on a storage medium which can be read by a computer and which comprises instructions for causing a computer to execute the method according to any one of claims 16-17.

19. A method for reading a coding pattern (3) which is located in an image and which comprises symbols (4), wherein the symbols represent at least two different values, each symbol comprising a raster point (5) and at least one marking (6); the raster point being included in a raster which extends over the surface; the value of each symbol being indicated by the placement of the said marking in relation to a raster point; and comprising the step of determining markings which at least partially

(continued)

(continued claim 19)

overlap one another and of reading for each one of these overlapping markings at least one contrasting indicator (63, 64, 68, 67, 70), the spatial extent and place within the marking of which indicate the placement of the marking.

20. A computer program which is stored in a storage medium which can be read by a computer and which comprises instructions for causing a computer to execute the method according to claim 19.

21. An apparatus for reading a coding pattern (3) which is located in an image and which comprises symbols (4), wherein the symbols represent at least two different values, each symbol comprising a raster point (5) and at least one marking (6); the raster point being included in a raster which extends over the surface; the value of each symbol being indicated by the placement of said marking in relation to a raster point; and comprising means for determining markings which at least partially overlap one another and means for reading for each one of these overlapping markings at least one contrasting indicator (63, 64, 68, 69, 70), the spatial extent and place within the marking of which indicate the placement of the marking.

22. An apparatus according to claim 21, wherein the apparatus is handheld.

23. An apparatus according to any one of claims 21-22, wherein the apparatus has means (19) for wirelessly transferring information.

Abstract of the Disclosure

A product according to the invention has according to one aspect a surface which is provided with an image in the form of a coding pattern. The coding pattern comprises symbols which represent at least two different values and where each symbol comprises a raster point and at least one marking. The raster point is included in a raster which extends over the surface and the value of each symbol is indicated by the placement of the marking in relation to a raster point. The markings each have a spatial extent which, in combination, at least partially form the image.

Published figure: Fig. 5a.